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A Resource Management Approach to Carbon Dioxide during the Century of Transition

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Abstract

The atmosphere is a global resource which countries must manage for mutual benefit. The increasing accumulation of carbon dioxide (CO_2) in the atmosphere is expected to raise the temperature of the earth, which would have major impact on world climates, ocean currents, and growing seasons. The CO_2 buildup arises primarily from the use of fossil fuels and to a much lesser extent from deforestation and poor management of soils. This means that the CO_2 problem should be viewed foremost as a problem in developing the appropriate transition strategy for moving from a fossil fuel to a nonfossil fuel economy in the next fifty to one hundred years. A CO_2 strategy should seek to manage carbon dioxide emissions so as to limit the increase in temperature or at least to delay it sufficiently to develop new technologies for storing and recycling carbon dioxide and to prepare for anticipated changes in climate. Proposed measures include controls on CO_2 emissions, selective use of renewable resources and of those fossil fuels with relatively low CO_2 content, conservation of energy resources, and environmentally sound management of forests and soils for substained yields. These elements comprise the "CO_2 transition strategy" for managing the atmosphere.

I. INTRODUCTION

Partly as a result of the world's increasing use of fossil fuels, carbon dioxide is accumulating in the atmosphere at a rate estimated to double the present concentrations by the year 2050.[1] Carbon dioxide in the atmo-

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1. CLIMATE RESEARCH BOARD, NATIONAL RESEARCH COUNCIL, U.S. NATIONAL ACADEMY OF SCIENCES, CARBON DIOXIDE AND CLIMATE: A SCIENTIFIC ASSESSMENT (1979), [hereinafter cited as NATIONAL RESEARCH COUNCIL REPORT]; G. WOODWELL, G. MACDONALD, R. REVELLE & C. KEELING, THE CARBON DIOXIDE PROBLEM: IMPLICATIONS FOR POLICY IN THE MANAGEMENT OF ENERGY AND OTHER RESOURCES (1979), [hereinafter cited as CEQ REPORT], *reprinted in* SENATE COMM. ON GOVERNMENTAL AFFAIRS, 96TH CONG., 1ST SESS., SYMPOSIUM ON CARBON DIOXIDE ACCUMULATION IN THE ATMOSPHERE, SYNTHETIC FUELS AND ENERGY POLICY 44 (1979)

sphere traps infrared radiation coming from the earth's surface and prevents it from escaping into outer space, thereby raising the temperature of the earth's surface. This phenomenon is commonly known as the "greenhouse effect." If the present atmospheric concentration of carbon dioxide doubled, world climate models predict an average global surface warming between 2°C and 3.5°C, with greater temperature increases at higher latitudes.[2]

This increase in the global surface temperature would have a major impact on the world's climates, ocean currents, and growing seasons. It would significantly disrupt agricultural production and water supplies in some areas.[3] At some point, increased concentrations of carbon dioxide could cause the floating ice in the Arctic to disappear and could trigger the disintegration of the West Antarctic Ice Sheet, consequently raising the sea level as much as fifteen to twenty feet.[4] The President's Council on Environmental Quality has concluded that this projected increase in carbon dioxide poses "one of the most important contemporary environmental problems" and "threatens the stability of climates worldwide and therefore, the stability of all nations."[5]

The rapid increase in the atmospheric concentration of carbon dioxide is well documented. Scientists do not agree, however, on the rates of projected increases and their climatic effects, the sources of a carbon dioxide buildup, or the capacity of existing reservoirs in the global system to absorb future increases in carbon dioxide. Yet there is a clear warning from the scientific community that the process of managing the carbon dioxide buildup must be initiated, and that strategies for adapting to its impact must be designed and implemented. The problem becomes particularly important in light of the nation's new policy favoring rapid development of coal resources. The President's Commission on Coal concluded that in order to reduce dependency on foreign oil, coal must replace oil and natural gas as the primary energy source.[6] Coal releases much more carbon dioxide than oil or natural gas.[7]

The carbon dioxide problem challenges the international community to break new ground to handle its unique blend of political, economic,

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[hereinafter cited as CO_2 SYMPOSIUM].

2. NATIONAL RESEARCH COUNCIL REPORT, *supra* note 1, at 1. For a general description of the "greenhouse effect," *see* CEQ REPORT, *supra* note 1, *reprinted in* CO_2 SYMPOSIUM, *supra* note 1, at 45-47.

3. Schneider, *So What If Climate Changes?, reprinted in* CO_2 SYMPOSIUM, *supra* note 1, at 78. *See also* S. SCHNEIDER, THE GENESIS STRATEGY (1976).

4. S. Schneider & R. Chen, Carbon Dioxide Warming and Coastline Flooding: Physical Factors and Climatic Impact (1980) (unpublished paper available from the National Center for Atmospheric Research, Boulder, Colorado).

5. CO_2 SYMPOSIUM, *supra* note 1, at iii.

6. President's Commission on Coal, Recommendations and Summary Findings (1980).

7. MacDonald has concluded that coal releases 2.5 (x 10^{15} g) of carbon dioxide per 100 quads of energy, while oil releases 2.0 and gas 1.45. CEQ REPORT, *supra* note 1, *reprinted in* CO_2 SYMPOSIUM, *supra* note 1, at 50.

legal, and scientific issues. How, in the face of serious scientific uncertainties, should states manage the emission and release of carbon dioxide into the atmosphere, when many states contribute to the problem in widely varying degrees, when all states will be affected by the resulting climate change but in different ways, when the activities contributing to a carbon dioxide buildup are central to the energy and land-use practices of states, and when costly preventive strategies, to be effective, would have to be initiated at least a decade or more before the full effects of CO_2-induced climate change would be felt? As a preliminary approach to the problem, this article briefly reviews international law as it is concerned with transboundary environmental pollution and shared resources, and discusses both its usefulness and its limitations as precedent for handling the carbon dioxide problem. It then suggests possible strategies for managing the increasing emissions of carbon dioxide into the atmosphere.

II. DESCRIPTION OF THE CARBON DIOXIDE PROBLEM

Conceptually, the global increase in carbon dioxide is a problem in the management of a scarce natural resource: the quality of the global atmosphere. Part of this is an international pollution problem: states dump carbon dioxide pollutants into the atmosphere; this can lead to a decrease in the quality of global resources. Since fossil fuel resources are limited and likely to be replaced by alternative energy supplies in the future, the steady buildup of carbon dioxide is a phenomenon which will take place only for the next fifty to one hundred years. The problem is thus one of managing the atmosphere during the transition from a fossil fuel economy to a nonfossil fuel economy.

Carbon dioxide is a gaseous byproduct of the use of fossil fuels, of deforestation, and of other activities. It may be viewed as a pollutant.[8] In economic terms, countries that develop fossil fuels and emit carbon dioxide into the atmosphere are using the atmosphere as a free good in developing their own resources. They are not internalizing the cost of the diseconomies they are inflicting upon the atmosphere by developing these resources. One can approach this problem either by regulatory mechanisms which seek to limit the amount of emissions or by economic incentives, including taxes, which prompt contributors to take measures to limit the amount of emissions. Domestically, the United States has had some experience in managing air,[9] water,[10] noise,[11] and other forms of pol-

8. While there is evidence that increased CO_2 concentrations in the atmosphere will have a positive impact on agriculture in some parts of the world, the author believes the predicted adverse consequences of the "greenhouse effect" justifies its classification as a pollutant. *See also* text accompanying notes 4-5 *supra*, and notes 70-80 *infra* on incentives for cooperation.

9. Clean Air Act, 42 U.S.C. § 7401 (1976 & Supp. III 1979).

10. Clean Water Act, 33 U.S.C. §§ 1251 *et seq.* (1976 & Supp. III 1979); Safe Drinking Water Act, 42 U.S.C. §§ 300(f)-(j-10) (1976 & Supp. III 1979).

11. Noise Control Act, 42 U.S.C. § 4901 (1976).

lution.[12] Internationally, various countries and organizations have had experience in dealing with pollutants which destroy the ozone layer,[13] and with ocean,[14] river,[15] outer space,[16] and air pollution.[17] Conceptually, the issues are not completely new. What makes the carbon dioxide problem so uniquely difficult is that it is caused by many point sources of pollution and that the pollutants emerge as byproducts of the use of critical natural resources—the consumption of fossil fuels, and to an extent yet unknown, the harvesting of forests and the misuse of soils. Moreover, the problem develops slowly with no immediate health or environmental effects, making it all the more difficult to convince decisionmakers to take immediate action.[18] Approaching the CO_2 problem as a pollution problem reveals its basic nature: it is a problem in energy management.

There appear to be two major sources for the buildup of carbon dioxide: (1) fossil fuels; and (2) deforestation. The first is well documented, but there is considerable uncertainty about the net contribution of the

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12. *See, e.g.*, Toxic Substances Control Act, 15 U.S.C. § 2601 (1976); Resource Conservation and Recovery Act, 42 U.S.C. § 6901 (1976).

13. *See, e.g.*, Agreement on Monitoring of the Stratosphere, May 5, 1976, United States-France-United Kingdom, 27 U.S.T. 1437, T.I.A.S. No. 8255, *reprinted in* [1978 Reference File] 1 INT'L ENVIR. REP. (BNA) ¶ 21:2501. For further discussion, *see* notes 56-68 *infra* and accompanying text.

14. *See, e.g.*, International Convention for the Prevention of Pollution of the Sea by Oil, *opened for signature* May 12, 1954, 12 U.S.T. 2989, T.I.A.S. No. 4900, 327 U.N.T.S. 3, *as amended* Apr. 11, 1962, 17 U.S.T. 1523, T.I.A.S. No. 6109, 600 U.N.T.S. 332, *as amended* Oct. 21, 1969, 28 U.S.T. 1205, T.I.A.S. No. 8505; *reprinted in* [1978 Reference File] 1 INT'L ENVIR. REP. (BNA) ¶ 21:0301; Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, *opened for signature* Dec. 29, 1972, 26 U.S.T. 2403, T.I.A.S. No. 8165, *entered into force* for the United States, Aug. 30, 1975.

15. *See, e.g.*, Helsinki Rules on the Uses of the Waters of International Rivers, U.N. Doc. A/CN.4/274, *reprinted in* YEARBOOK OF THE INTERNATIONAL LAW COMMISSION, U.N. Doc.A/CN.4/SER.A/1974/Add.1 (part 2), at 357; also *reprinted in* INTERNATIONAL LAW ASSOCIATION, REPORT OF THE FIFTY-SECOND CONFERENCE, HELSINKI 484 (1966) [hereinafter cited as Helsinki Rules]; Treaty Relating to Boundary Waters Between the United States and Canada, Jan. 11, 1909, United States-United Kingdom, 36 Stat. 2448, T.S. No. 548 [hereinafter cited as 1909 U.S.-Canada Treaty]; Convention on the Protection of the Rhine Against Chemical Pollution, *done at* Bonn, Dec. 3, 1976, *reprinted in* 16 INT'L LEGAL MAT. 242 (1977) [hereinafter cited as Rhine Chemical Convention]. For further discussion, see notes 25-47 *infra* and accompanying text.

16. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *done* Jan. 27, 1967, art. IX, 18 U.S.T. 2410, T.I.A.S. No. 6347, 610 U.N.T.S. 205.

17. Convention on Long-Range Transboundary Air Pollution, *done* Nov. 13, 1979, 7 U.N. ECE, Annex I, U.N. Doc. E/ECE/HLM.1/2 (1979), *reprinted in* 18 INT'L LEGAL MAT. 1442 (1979) [hereinafter cited as TBAP Convention]; The Nordic Convention on the Protection of the Environment, *done at* Stockholm, Feb. 19, 1974, *reprinted in* 13 INT'L LEGAL MAT. 591 (1974) [hereinafter cited as Nordic Convention]. For further discussion, see notes 48-66 *infra* and accompanying text.

18. In contrast, the fact that scientific studies linked depletion of the ozone layer to increased incidence of skin cancer undoubtedly contributed to prompt adoption of legislation banning the use of chlorofluorocarbons in aerosol spray cans. *See* text sec. IV(E) *infra*.

latter.[19] To the extent that the CO_2 buildup is primarily attributable to the use of fossil fuels, the problem is one arising mainly from the activities of developed countries. To the extent that deforestation is involved, a wider community of states are contributing actors. Identification of those states that are sources of carbon dioxide is important in fashioning the appropriate international regime. Rotty has estimated the percentage contribution of various areas of the world to atmospheric carbon dioxide emissions, as of 1974 and projected to the year 2025. In 1974, the United States, the Soviet Union, Eastern Europe, and Western Europe accounted for seventy percent of all CO_2 emissions, with the United States and Western Europe accounting for forty-five percent.[20] This suggests that at present it is potentially feasible for a handful of countries to join in multilateral initiatives aimed at curtailing carbon dioxide emissions, although it will be essential to build support for such measures in the larger world community.[21]

III. INTERNATIONAL LAW AND CARBON DIOXIDE POLLUTION

International law embodies two principles which apply to the management of carbon dioxide accumulations: (1) a principle of "equitable use," applicable to countries using a shared natural resource; and (2) a principle which makes states responsible for damage caused to the environment of other states in areas beyond their jurisdiction. The Stockholm Declaration on the Human Environment, adopted in 1972, provides that "States have, in accordance with the Charter of the United Nations and the principles of international law . . . the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."[22] These principles have been adopted in some international

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19. *See generally* Adams, Mantovani & Lundell, *Wood Versus Fossil Fuel as a Source of Excess Carbon Dioxide in the Atmosphere: A Preliminary Report*, 196 SCIENCE 54-56 (1977); Bolin, *Changes of Land Biota and Their Importance for the Carbon Cycle, id.* at 613-15; Stuiver, *Atmosphere Carbon Dioxide and Carbon Reservoir Changes*, 199 SCIENCE 253-58 (1978); Woodwell, Whittaker, Reiners, Likens, Delwiche & Botkin, *The Biota and the World Carbon Budget, id.* at 141-46.

20. CO_2 SYMPOSIUM, *supra* note 1, at 158. Rotty projects that by the year 2025, the primary contributors of carbon dioxide accumulation will shift from developed to developing countries. He estimates that, in 50 years, the LDC's will comprise 40% of the global emissions of carbon dioxide while the emissions from the U.S., U.S.S.R., and European nations will total 28%. *Id.* For detailed analysis of projected rates of energy use by region, *see* R. Rotty & G. Marland, Constraints on Carbon Dioxide Production from Fossil Fuel Use (May 1980) (Institute for Energy Analysis, Oak Ridge).

21. The total picture narrows when the carbon wealth of nations is viewed exclusively in terms of coal. In such an analysis, the U.S., U.S.S.R., and China are the main contributors.

22. Stockholm Declaration of the United Nations Conference on the Human Environment (Stockholm, 5-16 June 1972), 1 U.N. GAOR (21st plen. mtg.), U.N. Doc. A/CONF.48/14 Rev. 1 (1972), *reprinted in* 11 INT'L LEGAL MAT. 1416 (1972) [hereinafter cited as Stockholm Declaration]. The final report of the Stockholm Conference is conveniently reprinted in a Senate Foreign Relations Committee publication: SENATE COMM. ON FOREIGN RELA-

agreements governing air and water pollution and the use of international rivers.[23] They have been used to develop processes for information exchange, coordination, consultation, and compensation for harm suffered.[24]

A. *International Rivers*

The underlying legal standard embodied—either explicitly or implicitly—in arrangements for managing international rivers and river basins is that of "equitable utilization." The principle is implemented primarily through water allocation and quality control mechanisms and compensatory schemes.

The Helsinki Rules on the Uses of the Waters of International Rivers, adopted by the International Law Association in 1966, impose a duty on states to prevent future pollution of international drainage basins[25] and require violators to cease the wrongful conduct and compensate the injured co-basin state.[26] The rules also suggest that states should take "all reasonable measures" to abate existing problems[27] and enter into negotiations to achieve this end.[28] The 1909 Treaty between the United States and Great Britain Relating to Boundary Waters and Questions Arising Between the United States and Canada, which was designed to prevent boundary water disputes, also prohibits transboundary water pollution.[29] The 1978 Agreement Between the United States and Canada on Great Lakes Water Quality carries this provision forward and requires the parties to use "best efforts" to ensure water quality standards are met.[30] The International Joint Commission, a fact-finding body established to imple-

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TIONS, 92D CONG., 2D SESS., UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT—REPORT TO THE SENATE BY SENATOR CLAIBORNE PELL AND SENATOR CLIFFORD CASE 12-90 (Comm. Print 1972). A House Public Works Committee print includes a summary of the Conference's recommendations and outlines the position taken by the United States on the matters discussed at the Conference. STAFF OF HOUSE COMM. ON PUBLIC WORKS, 92D CONG. 2D SESS., REPORT ON THE UNITED NATIONS CONFERENCE ON THE HUMAN ENVIRONMENT (Comm. Print 1972).

23. *See* Handl, *The Principle of "Equitable Use" as Applied to Internationally Shared Resources: Its Role in Resolving Potential International Disputes over Transfrontier Pollution*, REVUE BELGE DE DROIT INTERNATIONAL (1978-79). *See also* The Indus Water Treaty, Sept. 19, 1960, India-Pakistan-I.B.R.D., 419 U.N.T.S. 125; Agreements for the Full Utilization of the Nile Waters, Nov. 8, 1959, U.A.R.-Sudan, 453 U.N.T.S. 51; Treaty Relating to the Uses of Waters of the Niagara River, Feb. 27, 1950, United States-Canada, 1 U.S.T. 694, T.I.A.S. No. 2130, Treaty Relating to the Utilization of the Waters of the Colorado and Tijuana Rivers, and of the Rio Grande, Feb. 3, 1944, United States-Mexico, 59 Stat. 1219, T.S. No. 994.

24. Weiss, *International Liability for Weather Modification*, 1 CLIMATIC CHANGE 267 (1978).

25. Helsinki Rules, *supra* note 15, art. X(1)(a).

26. *Id.* art. XI(1).

27. *Id.* art. X(1)(b).

28. *Id.* art. XI(2).

29. 1909 U.S.-Canada Treaty, *supra* note 15, art. IV.

30. Agreement on Great Lakes Water Quality, Nov. 22, 1978, United States-Canada, art. II, 30 U.T.S. 1383, T.I.A.S. No. 9257 [hereinafter cited as 1978 Great Lakes Agreement].

ment the 1909 Treaty,[31] assists in implementing the 1978 Agreement.[32]

As between the United States and Mexico, an 1889 convention[33] and a 1944 treaty[34] govern water allocation and boundary line disputes. An International Boundary and Water Commission implements these agreements.[35] The United States and Mexico are expanding their efforts to include measures for water quality control. A memorandum of understanding between the Sub-secretariat for Environment Improvement of Mexico and the United States Environmental Protection Agency, signed on June 14-19, 1978, provides for consultation and an exchange of experts to resolve environmental problems.[36] It calls for periodic meetings and parallel efforts toward research and monitoring of pollution. These two agencies are also to devise an early warning system for potential environmental problems.[37]

There are a number of river basin agreements designed to promote the harmonious development of a region, such as the Treaty on the Platé River Basin of 1969,[38] to which Argentina, Bolivia, Brazil, Paraguay and Uruguay are contracting parties. Such agreements traditionally provide for a committee to coordinate use of the water resources.[39] The problem is that these provisions usually exist only in form.

Several Western Europe countries—France, West Germany, Luxembourg, Switzerland and the Netherlands—have undertaken measures to prevent and abate pollution of the Rhine.[40] Under the Convention on the Protection of the Rhine Against Chemical Pollution, the parties agree to eliminate or reduce the discharge of certain enumerated pollutants to specified emission standards.[41] The International Commission for the Protection of the Rhine Against Pollution coordinates the implementa-

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31. 1909 U.S.-Canada Treaty, *supra* note 15, art. VIII.

32. 1978 Great Lakes Agreement, *supra* note 30, art. VII.

33. Convention to Facilitate the Carrying Out of the Principles Contained in the Treaty of November 12, 1884, Mar. 1, 1889, United States-Mexico, 26 Stat. 1512, T.S. No. 232 [hereinafter cited as 1899 U.S.-Mexico Convention].

34. Treaty Relating to the Utilization of Waters, Feb. 3, 1944, United States-Mexico, arts. 2 & 3, 59 Stat. 1219, T.S. No. 944 [hereinafter cited as 1944 U.S.-Mexico Treaty].

35. 1899 Convention U.S.-Mexico, *supra* note 33, art. II; 1944 U.S.-Mexico Treaty, *supra* note 34, art. 1.

36. Memorandum of Understanding for Cooperation on Environmental Programs and Transboundary Problems, June 14-19, 1978, United States-Mexico, 30 U.S.T. 1574, T.I.A.S. No. 9264.

37. *Id.* ¶ 8.

38. Treaty on the Platé River Basin, *signed at* Brasilia, Apr. 23, 1969, art. 1, *reprinted in* 8 INT'L LEGAL MAT. 905 (1969).

39. The Platé River Basin Treaty establishes the Inter-Government Committee to perform this function. *Id.* art. III.

40. Rhine Chemical Convention, note 15 *supra;* Convention on the Protection of the Rhine Against Pollution by Chlorides, *done at* Bonn, Dec. 3, 1976, *reprinted in* 16 INT'L LEGAL MAT. 265 (1977) [hereinafter cited as Rhine Chloride Convention].

41. Rhine Chemical Convention, *supra* note 15, arts. 1-4.

tion of the agreement.[42] A more recent agreement, the Convention on the Protection of the Rhine Against Pollution by Chlorides, has not yet entered into force.[43] This convention calls for the reduction of the chloride content in the Rhine waters along the Dutch/German border, which has resulted from the injection of chloride wastes into the subsoil in the Alsace region.[44] Potassium mining in that region is the primary source of this pollutant.[45] The French safeguard is its unilateral right to cease injections when they appear to pose a "serious danger to the environment."[46] Nevertheless, this convention has met with considerable opposition in France. Consequently, the French government has been unable to ratify the agreement in Parliament, much to the distress of the Dutch.[47]

Experience with international rivers and river basin agreements suggests that it will be difficult to negotiate effective arrangements to manage carbon dioxide accumulations. In general, these agreements have shown that upstream users put downstream users at their mercy. Experience with the Rhine conventions demonstrates the political obstacles that confront the implementation of multilateral efforts to control water pollution.

B. *Air Pollution*

Existing conventions concerned with air pollution, like the water pollution agreements, break down into two basic groups. The first impose an obligation on a contracting party to inform and consult with another state when activities within the jurisdiction of the former may adversely affect the environment of the latter. These agreements also typically contain arrangements for coordinated research programs and data exchanges. Examples include the 1979 Convention on Long-Range Transboundary Air Pollution[48] and the 1976 Agreement on Monitoring of the Stratosphere.[49] The second kind of agreement goes one step further to include provisions for dispute resolution, such as a right of access to domestic courts or administrative bodies, or establishment of an impartial fact-finding commission. The Nordic Convention on the Protection of the Environment[50] and the United States-Canadian International Joint Commission's Michigan-Ontario Air Pollution Board[51] are good examples of the latter kind.

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42. *Id.* art. 2.

43. [1979] 2 INT'L ENVIR. REP. (BNA) 975.

44. Rhine Chloride Convention, *supra* note 40, art. 2.

45. [1979] 2 INT'L ENVIR. REP. (BNA) 975.

46. Rhine Chloride Convention, *supra* note 40, art. 2.

47. The Dutch, the downstream recipients of pollution in the Rhine, recalled their ambassador from Paris after the French government withdrew its bill for ratifying the Convention from Parliament. Moreover, the Dutch requested the EEC to pressure the French to ratify the agreement. [1979] 2 INT'L ENVIR. REP. (BNA) 975.

48. TBAP Convention, note 17 *supra*.

49. Agreement on Monitoring of the Stratosphere, note 13 *supra*.

50. Nordic Convention, note 17 *supra*.

51. 1974 Michigan/Ontario Memorandum of Understanding on Transboundary Air Pol-

The most recent international agreement concerned with air quality is the Convention on Long-Range Transboundary Air Pollution, which has been signed by thirty-five countries including the United States, Canada, and most of the countries in Eastern and Western Europe.[52] The agreement imposes an obligation on contracting parties to consult on request on activities which affect or pose a "significant risk" of long-range transboundary air pollution.[53] The legal duty to combat the discharge of air pollutants is admittedly weak. States are merely required to act "without undue delay."[54] To its credit, the Convention contains lengthy provisions on research, monitoring, and information exchange, which are aimed at mitigating sulphur dioxide (SO_2) emissions.[55]

The 1976 Agreement on Monitoring of the Stratosphere—to which the United States, France, and the United Kingdom are the contracting parties—concentrates solely on increasing scientific understanding of the ozone layer.[56] It requires the parties to collect, exchange, and analyze information on the stratosphere, and to fully integrate their activities with the existing international networks of the World Meteorological Organization and the U.N. Environment Programme.[57] One purpose of the agreement is to demonstrate the feasibility and utility of collaborative international action in this area.[58]

The Nordic Convention, in contrast to the above-mentioned agreements, provides a framework for abatement and for compensatory relief for persons injured by transboundary air and water nuisances.[59] It requires the contracting parties—Denmark, Finland, Norway, and Sweden—to accord to noncitizens equal access to administrative agencies and domestic courts, and guarantees of nondiscriminatory treatment.[60] It gives to any person who is affected or may be affected "by environmentally harmful activities" the right to ask for measures to prevent damage,[61] and provides for compensatory relief.[62] Although this process could conceivably be applied to enjoin activities until carbon dioxide standards are met, it is probably not practical as a workable solution to the carbon

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lution Control (June 26, 1975) (available from the International Joint Commission); Reference from the Governments of the U.S. and Canada (July 8, 1975) (available from the International Joint Commission).

52. [1979] 2 INT'L ENVIR. REP. (BNA) 976-77.

53. TBAP Convention, *supra* note 17, art. 5.

54. *Id.* art. 3.

55. *Id.* arts. 6-9.

56. Agreement on Monitoring of the Stratosphere, *supra* note 13, arts. II-IV.

57. *Id.* art. VI.

58. *Id.* art. I.

59. Nordic Convention, note 17 *supra*. *See also* OECD Council Recommendation on the Equal Rights of Access to Information, Participation in Hearings and Procedures by Persons Affected by Transfrontier Pollution, *adopted* May 11, 1976, *reprinted in* 15 INT'L LEGAL MAT. 1218 (1976).

60. *Id.* art. 3.

61. *Id.*

62. *Id.*

dioxide situation.

Coordinated monitoring and emission regulations, on the other hand, are not only viable but have been utilized in other transboundary air pollution situations. The International Joint Commission (IJC) between the United States and Canada undertook in the early 1970's to mitigate air pollution problems between Michigan and Ontario.[63] To assist its efforts, the IJC established, in 1976, the International Michigan-Ontario Air Pollution Board.[64] The function of this board is to coordinate the implementation of air pollution control programs, including setting a minimum basis for emission standards.[65] As a result of this effort, the air quality in the area seems to have improved, with the percentage of those air quality readings failing to meet the IJC objectives declining throughout the region.[66]

International agreements concerned with managing air pollution offer at least some limited positive experiences to draw upon in developing a framework for managing carbon dioxide accumulations. Certainly, they suggest that international scientific cooperation in the gathering and exchange of data and in monitoring CO_2 accumulations would be a desirable and feasible step. The monotoring of CO_2 might even be included in the existing networks for monitoring sulphur dioxide, chlorofluorocarbons, and other air pollutants.

In addition to the formal agreements concerned with air and water pollution, there are a number of arbitral decisions and negotiated settlements which incorporate the principles of equitable use and state responsibility for environmental harm. The *Trail Smelter Arbitration* is one of the most frequently cited cases.[67] In this case Canada was held liable for damage in the State of Washington from the fumes emitted by a Canadian smelting company. Even though Canada had admitted liability in the compromis establishing the Tribunal, the final decision in 1941 declared that

> [t]he tribunal, therefore, finds [that] . . . under the principles of international law, as well as of the law of the United States, no state has the right to use or permit use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence.[68]

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63. *See* note 51 *supra*.

64. International Joint Commission, Second Annual Report on Michigan/Ontario Air Pollution 2 (1977) (available from the IJC).

65. *Id.* at 1-2.

66. *Id.* at 2-4.

67. Trial Smelter Arbitration (United States v. Canada), 3 R. Int'l Arb. Awards 1911 (1938), *id.* at 1905 (1941), *reprinted in* 33 AM. J. INT'L L. 182 (1939) and 35 AM. J. INT'L L. 684 (1941).

68. *Id.* at 1965. Decisions of such arbitral tribunals are binding only on the parties to the arbitration, yet nevertheless remain important indicators of international law and derive much of their force from the extent to which principles enunciated therein are incorporated

A number of diplomatic settlements at least implicitly recognized state responsibility for the consequences of pollution inflicted upon other countries. For example, Mexico complained to the United States that the water it received from the Colorado River was too saline to be useful to Mexico and hence in violation of the 1944 treaty between the two countries. The Mexicans argued that the treaty included a water quality standard, a point disputed by the United States. In settling this dispute with Mexico, the United States agreed to provide compensation in the form of assistance to rehabilitate the Mexicali Valley from the damages suffered from the saline pollution, although it did not actually acknowledge any obligation to do so in international law.[69]

The U.N. General Assembly Resolution on Environmental Cooperation Concerning Natural Resources Shared by States calls for an exchange of information and for prior consultation in the use of shared resources.[70] States engaging in activities which potentially could cause pollution harmful to other states may have a duty to consult with those states or at least offer them an opportunity to engage in consultation. The value of consultation is that it offers a process by which to minimize harm and political conflict and, in the best of cases, to negotiate mutually acceptable arrangements between the concerned states.

IV. POLLUTION MANAGEMENT STRATEGIES

A. *Introduction*

The increasing concentration of carbon dioxide in the atmosphere may be viewed as a global pollution problem caused primarily by point sources of pollution. If it turns out that the main polluters (that is, the main producers of CO_2) are also the countries that would be most hurt by a change in climatic conditions triggered by a CO_2 buildup, then it would be in their interest to develop jointly an allocation regime for CO_2 emissions in order to delay or avert such climatic change. If, on the other hand, there are important contributors to the CO_2 concentration in the atmosphere that stand to benefit from CO_2-induced climate changes, it will be very difficult to develop an effective allocation regime.

This is complicated by the fact that most of the scientific factors are still unclear: the relative importance of different sources for the higher CO_2 concentration in the atmosphere, the eventual fate of CO_2 in the global system, and the impact of a given level of CO_2 on the climate of specific regions and countries. Moreover, the elucidation of these underlying phenomena will probably require at least a decade of scientific research.

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in future decisions or agreements.

69. Agreement Confirming Minute 242 of the International Boundary and Water Commission, Aug. 30, 1973, United States-Mexico, 24 U.S.T. 1968, T.I.A.S. No. 7708.

70. G.A. Res. 3129, 28 U.N. GAOR, Supp. (No. 30) 49, U.N. Doc. A/9030 (1973), *reprinted in* 13 INT'L LEGAL MAT. 232 (1974).

For this reason, predictions of the political consequences of future climatic changes can be useful as illustrations of the kinds of political alignments that could take place as the world grapples with the carbon dioxide problem. Fortunately, the impact of carbon dioxide accumulation is still distant enough that countries can wait for better scientific information before taking difficult political actions.

Bearing this caveat in mind, preliminary data indicate that the United States and Europe are at once major contributors to the carbon dioxide increase and potential victims of CO_2-induced climate change.[71] In particular, U.S. agricultural production is predicted by some calculations to decrease as a result of warmer, drier weather in the grain belt,[72] while other portions of the country could be permanently submerged in the less likely event of the melting of the polar ice caps.[73] These predictions depend on uncertain scientific theories and do not take into account the ability of the United States to respond by technological innovation, for example, by developing new crop varieties or species adapted to the new climatic conditions. The United States and other developed nations may be able to adapt far more easily than other countries to adverse climatic change because of greater technical capabilities. Still, the possibilities enumerated above do suggest that the United States has considerable incentive to reduce CO_2 accumulations. From this projection, it appears to be in the interest of at least the United States and Europe to explore strategies for managing carbon dioxide emissions during the coming century.

Under some calculations, countries located in monsoon regions would benefit as warmer global temperatures trigger more favorable rains with accompanying improved crop production.[74] If these predictions are accepted, the possibility of such benefits can significantly affect the formation of an international consensus to control CO_2 emissions. Moves by the United States to limit CO_2 "pollution" would understandably be seen as another example of "environmental imperialism," especially to those beneficiaries who would not view the problem as "pollution" at all. But even those countries that would benefit will find the process of adapting to CO_2-induced climate change difficult. Moreover, the calculations of climate effects are still uncertain. Since developing countries are predicted by Rotty to become significant sources of CO_2 emissions by the year

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71. R. Rotty, Growth in Global Energy Demand and Contribution of Alternative Supply Systems (Institute for Energy Analysis, Oak Ridge Associated Universities, 1979); R. Rotty, Past and Future Emission of Carbon Dioxide (Institute for Energy Analysis, Oak Ridge Associated Universities, 1980).

72. W. BACH, IMPACT OF WORLD FOSSIL FUEL USE ON GLOBAL CLIMATE: POLICY IMPLICATIONS AND RECOMMENDATIONS, *reprinted in* CO_2 SYMPOSIUM, *supra* note 1, at 121; Cooper, *What Might Man-Induced Climate Change Mean?* 56 FOREIGN AFF. 500, 513 (1978).

73. Schneider, note 3 *supra*.

74. Cooper, *supra* note 72, at 507. For a complete analysis, *see* Bryson, *A Perspective on Climate Change*, 184 SCIENCE 753 (1974).

2025,[75] their participation in any program to limit CO_2 emissions will be important. Unless the United States and other developed countries presently responsible for most of the CO_2 emissions are willing to initiate measures to limit CO_2 buildup in the atmosphere, developing countries are unlikely to be willing to shoulder the burden later, and maximum U.S. initiatives then may have only minimal impact on abating the problem.

One of the major contributors of CO_2 emissions today, the U.S.S.R., is a possible net gainer. Warming global temperature is predicted to increase agricultural productivity by lengthening the growing season for some presently unproductive land.[76] China, which holds a major share of the earth's coal, could also benefit agriculturally. Rice yields are predicted to increase and multiple seasons are possible.[77] If these predictions are accepted, there may be few incentives for the Soviet Union and China to engage in international cooperation to manage CO_2 accumulations.

Predictions as to the likely effect of a given increase in carbon dioxide on specific regions are still far from certain and more research is needed. If it can be assumed that the United States and other developed countries in the northern hemisphere either would benefit from the climatic change or could easily adapt to it and that areas in the developing world will become increasingly arid and agriculturally unproductive, then there may be significant incentives for international cooperation flowing from the demands of the developing world for a redistribution of the wealth.[78]

A complete analysis of the possible effects of an increase in carbon dioxide on key CO_2 contributors—those emitting now and in the future—is essential to an elimination of the shroud of uncertainty currently surrounding this issue.

In order to devise appropriate strategies for managing carbon dioxide emissions, data which will demonstrate who the important actors are and what proportion they are contributing to the pollution problem are needed. Such data should give a breakdown by states or major contributors to the increased carbon dioxide pollution, both now and projected into the future, and a breakdown which shows how much of the pollution is from fossil fuels, how much from deforestation, and how much from still other sources. Within the fossil fuel category, it is necessary to know which fuels contribute most to the carbon dioxide buildup. While Rotty's

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75. *See* note 20 *supra* and accompanying text.

76. Cooper, *supra* note 72, at 505. While Canada will experience a similar lengthening of its growing season, this change will be less beneficial since much of the land affected would be located on the Laurentian Shield. *Id.* at 513. *See* Rotty, note 71 *supra*.

77. Bach, *reprinted in* CO_2 SYMPOSIUM, *supra* note 1, at 138; Cooper, *supra* note 72, at 514-15.

78. *See* Report of Thomas C. Shelling, Ad Hoc Study Panel on Economic and Social Aspects of Carbon Dioxide Increase, to Philip Handler, National Academy of Sciences (Apr. 18, 1980).

data shows global carbon dioxide production by world segments for the year 1974 and projected to the year 2025,[79] Steinberg, Albanese and Vi-Doung have prepared a table showing carbon dioxide generation as a function of fuel source.[80] Such tables are essential for later assessments of appropriate institutional arrangements. It will also be useful to have a breakdown in the use of fossil fuel as to residential heating, gasoline, petrochemicals, and other fossil fuel products, and what part of this use, current and projected, involves coal.

Carbon dioxide as a pollution problem is foremost an energy policy problem. This means that it is important to analyze the workings of the current oil economy, to investigate the private sector's and the public sector's outlook for the development and marketing of coal resources and to consider and involve the private sector in the management of the carbon dioxide problem. The international oil companies have substantial investments in coal and oil shale and thus they will continue to be important actors in the future. More importantly, the feasibility of technological innovations to reduce or recycle CO_2 emissions and the incentives needed to stimulate innovation must be explored and developed with the industries that use fossil fuels. To date little attention has been given to the question of how private industry might be involved in a resolution of the carbon dioxide problem.[81]

Much of the literature tends to discuss the problem in policy terms that suggest an immediate switching to a nonfossil fuel economy or leap to a discussion of managing the impacts of future climatic change.[82] Certainly these are policy elements that ought to be evaluated. But the question that has been largely overlooked and that needs to be addressed is how carbon dioxide emissions from fossil fuels are to be limited to a "manageable" amount that will delay the projected warming and allow time to develop new methods for preventing the release of CO_2 or recycling it to mitigate the climatic effects and for adapting to the resulting climatic change. This means that it is necessary to determine what kind of output of carbon dioxide would result in what kind of buildup in the system, and what rate of buildup of carbon dioxide can be absorbed over what periods of time. Action may be taken at that point to determine

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79. CO_2 SYMPOSIUM, *supra* note 1, at 158.

80. *Id.* at 159.

81. No representatives from private industry were invited to the Senate Governmental Affairs Committee's carbon dioxide symposium. The West German government, however, is pursuing intensive research in conjunction with the German coal industry to develop a technical fix, scrubbers, for the carbon dioxide problem. CO_2 SYMPOSIUM, *supra* note 1, at 28. In a study for the U.S. Department of Energy, Albanese & Steinberg, of Brookhaven National Laboratory, investigated the practicability of alternative CO_2 control systems. They concluded that most potential CO_2 control systems reduce power generation efficiency and require significant energy input. Of the several options studied, the most promising is to store CO_2 in the deep ocean. Albanese & Steinberg, Environmental Control Technology for Atmospheric Carbon Dioxide (May 1980) (Brookhaven National Laboratory).

82. *See, e.g.*, Cooper, note 72 *supra*.

what measures may be necessary to insure that states do not exceed these amounts in their production and use of fossil fuels. Given these calculations, it would then be possible to prepare for worst case scenarios, as utility companies do in planning for fuel consumption during winter seasons.

The management of carbon dioxide pollution requires processes for risk assessment and impact evaluation, and preventive strategies at the national and international level.

B. *National Preventive Strategies*

Carbon dioxide pollution raises the possibility of significant, adverse, and irreversible climatic impacts which could be catastrophic to certain sectors of the economies of some countries. Yet, as discussed above, most of the important factors are still scientifically unknown and in dispute. This requires states to balance the economic costs of taking action at the present time with the economic costs of not acting, all in the face of scientific uncertainty. Since the former are usually easier to quantify, decisions are usually struck for the latter. Project Westford, which dispersed very fine copper needles into space, and the early NASA space experiments, are examples of situations where officials had to decide what confidence levels they required in assessing risks from the experiments.

The United States can take steps to control carbon dioxide emissions, if needed.[83] But the costs of these measures are not known and certainly need to be carefully assessed. Substantive measures which might be taken include the following: (a) requiring any federal environmental impact statement[84] concerned with a project that relies on fossil fuels to identify explicitly the impacts of carbon dioxide emissions into the atmosphere; (b) exploring the feasibility of the development and utilization of scrubbers to reduce carbon dioxide emissions or of methods to recycle carbon dioxide and analyzing the experience with the provisions of the Clean Air Act as they affect innovation in industry; (c) providing incentives to industry to engage in research and development which could lead to measures to reduce carbon dioxide emissions, and analyzing the export market potential for such measures; (d) imposing substantive limits on the production and consumption of coal (or other fossil fuels) and on the export of this resource to other countries, particularly Western Europe; (e) investigating other measures, such as provisions in the terms of lease for development of coal deposits and oil shale, which could provide for

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83. Some action has already been taken, for example, the July 30, 1979, Senate Committee on Governmental Affairs hearings exploring the relationship between carbon dioxide accumulation and synthetic fuels production. CO_2 SYMPOSIUM, note 1 *supra*. As a result of these hearings, Senator Ribicoff introduced an amendment authorizing the National Academy of Sciences to undertake a two-year study of the carbon dioxide problem. That amendment, with the bill, is now part of the Synthetic Fuels Act.

84. On the requirement of federal environmental impact statements, *see* National Environmental Policy Act of 1969, 42 U.S.C. § 4332(2)(c) (1976).

public intervention if needed, to manage the level of carbon dioxide emissions; and (f) allocating fuels, taking into account carbon dioxide generating power, with exemptions for plants with scrubbers or other means of limiting CO_2 emissions. Whether emissions control is a technically feasible goal is still unclear and controversial. Such controls will be adopted only if the costs to economic growth are acceptable, and these costs have yet to be defined.

C. *International Preventive Strategies*

Since the major contributors to the carbon dioxide buildup are presently only a handful of developed countries,[85] it should be possible to focus the initial discussions among these primary contributors—the United States, Western Europe and, if possible, the Soviet Union and Eastern Europe. Initial consultations might begin with the United States and Western European countries under the umbrella of the European Economic Community or the Organization for Economic Cooperation and Development (OECD), one component of which is the International Energy Agency. Again, it would be necessary to analyze the role that private industry could play. The oil market is an international one, and the coal market promises to be likewise. Discussions might focus on emission controls, as has been the case with air pollution in the United States[86] and in Europe. Emission controls ought to be keyed to acceptable limits which have been determined scientifically to be linked with given levels of temperature increases in the climate. Admittedly this requires considerable advances in our scientific knowledge, but obtaining sufficient knowledge to establish such limits should be a primary objective.

The OECD's Environment Committee at its May 1979 meeting recognized the potential concern of a carbon dioxide buildup from coal production.[87] The OECD's Council on Coal and the Environment specifically recommended that "member countries, in the light of appropriate research results, seek to define acceptable fuel qualities, emission levels or ambient media qualities, as appropriate for carbon dioxide."[88] This seems to encompass a scheme to control carbon dioxide emissions which would be similar to that employed in the United States: an international ambient standard for carbon dioxide, together with emission limitations designed to meet that ambient standard, which could be implemented at

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85. The Soviets have moved to convene a ministerial meeting of the United Nations Economic Commission for Europe (ECE) to discuss the world energy situation. A similar Soviet initiative last November resulted in the Convention on Long-Range Transboundary Air Pollution. While such a meeting would be an appropriate forum for discussing the carbon dixoide problem (the U.S., Canada, and Eastern and Western Europe are all members of the ECE), the chances for such a meeting are probably slim as long as Afghanistan and other situations remain unresolved. [1980] 339 ENERGY USERS REP. (BNA) 15. *See* note 20 *supra* and accompanying text. *See also* note 21 *supra*.

86. Clean Air Act, 42 U.S.C. § 7401 (1980).

87. OECD Environment Comm. Press Release (Paris, May 8, 1979).

88. Recommendation of the Council on Coal and the Environment, *id.* at 12.

the national level. In considering any such scheme, it would be important to analyze critically the experience of the United States with the Clean Air Act,[89] which provides for ambient air quality standards, to be achieved through emission controls, and the Clean Water Act,[90] which focuses mainly on effluent limitations, to be implemented by best available control technology.[91] If countries were to agree to an ambient standard for CO_2, it would be essential to have scientific input in establishing the standard. The allocation of emission limitations between countries would be a highly political decision, one which could prove to be intractable. Applying the emission limitations within each country would entail difficult political decisions about who had the right to contribute what amount of carbon dioxide to the atmosphere.

Predictions by Rotty indicate that by the year 2025, forty percent of the carbon dioxide buildup may come from the developing countries, which now contribute less than twenty percent.[92] Even if the projected contributions of the developing countries were considerably less, it would be essential to involve the participation of the rest of the world in any system of ambient standards and controls to be established. Initially this means at a minimum that efforts must be undertaken to build international consciousness of the problem and to elicit participation of other countries at conferences discussing the problem. Any system that is developed for limiting carbon dioxide concentrations in the atmosphere will eventually need to be carried forward with the participation of the developing countries. The issues raised at that point would be similar to those that arose at the Stockholm Conference on the Environment in 1972, at which developing countries expressed legitimate concern over the potential conflict between development strategies appropriate for their countries and the concerns of the international community which would make those strategies either more expensive or would otherwise impede their development.[93]

Various international institutions are concerned with the increased concentration of carbon dioxide in the atmosphere. These include the OECD, the EEC, the World Meteorological Organization, the U.N. Environment Programme (UNEP), the U.N. Development Programme, the U.N. Educational, Scientific and Cultural Organization, the International

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89. 42 U.S.C. § 7401 (1980).

90. *E.g.*, Clean Water Act, 33 U.S.C. § 1251 (Supp. I 1976).

91. The U.S. Clean Air Act embodies a two-step approach to maintaining and enhancing air quality. First, the federal government establishes a primary (for the protection of public health) and a secondary (for the protection of public welfare) national ambient air quality standard for each pollutant listed in the Act. 42 U.S.C. § 7409(b)(1980). Second, the states, through state implementation plans, formulate emission standards defining specific quantitative limits on the amount of the pollutants individual sources may release. 42 U.S.C. § 7410 (1980). For a discussion, *see* W. RODGERS, HANDBOOK ON ENVIRONMENTAL LAW 254-59 (1977).

92. *See* note 71 *supra* and accompanying text.

93. *See* Stockholm Declaration, note 22 *supra*.

Council of Scientific Unions, the International Institute for Applied Systems Analysis, and the NATO Committee on the Challenges of Modern Society. To date the role of these institutions has been limited to identifying the problem, monitoring and evaluating scientific data, collecting and exchanging information regarding the buildup, and the facilitation and coordination of national and international programs related to it. At least to some extent, these organizations, or an appropriate mix of them, could be employed in analyzing the impact of various policy choices regarding the management of carbon dioxide.

D. *Preventive Strategies for Deforestation*

In order to develop appropriate management strategies for a carbon dioxide buildup from deforestation, it is necessary to assess the amount to which deforestation does, in fact, contribute to an increase in carbon dioxide. The problem is to determine the direction and magnitude of the biospheric signal. Are the forests of the world being cut down at a rate that exceeds reforestation and that exceeds the progressively faster growth rates of forests that may result from increases in carbon dioxide? The dispute within the scientific community regarding the contribution of deforestation makes it especially difficult to develop strategies to manage it. After the geographical areas of concern have been identified, alternative ways to slow down the rate of deforestation, or to counteract its effects, must be developed and assessed. Some argue that it is not deforestation per se that produces CO_2, but rather the destruction of the organic matter of the soil that follows misuse of cleared land.

The problem for international attention is the development and implementation of environmentally sound strategies for sustained yield management of the forests and the soils. Any success in controlling CO_2 emissions is likely to come as a byproduct of progress on this general problem. A regime of separate emission limitations for CO_2 from the deforestation of tropical forests is not likely to be a useful or viable approach.

Any effort to control deforestation frontally assaults cherished notions of national sovereignty over the exploitation of a state's natural resources. States can therefore be expected to resist such measures. A first and necessary step will be to encourage efforts to raise international consciousness about the implications of forest and soil management strategies for levels of carbon dioxide in the atmosphere, the impact of these levels on global temperature, and the long-range implications of a rise in temperature for the economy and well-being of individual countries.

The community of actors in deforestation differs from that in the fossil fuel area. Most forests are in the developing world. Multinational companies and governments of at least some of the developed countries are frequently responsible for clearing forests. Thus, the appropriate forum for discussing this problem would be a broader based community than either the EEC or OECD. UNEP or FAO are possibilities.

UNEP has already focused some attention on the problem of deforestation. In 1979, UNEP's Governing Council adopted a resolution, introduced by the United States, calling for a meeting of experts to develop proposals for an integrated international program on the conservation and wise utilization of tropical forests.[94] The UNEP meeting in April 1980 in Kenya[95] also discussed the destruction of tropical forests, but without making any decisions.

In the United States, former President Carter's second environmental message to Congress on August 2, 1979, addressed two global environmental problems: acid rains and deforestation of tropical forests.[96] The President referred to estimates that the world forest could decline by twenty percent by the year 2000 and noted that "[f]orest loss may adversely alter global climate through the production of CO_2. These changes and their effects are not well understood and are being studied by scientists but the possibilities are disturbing and warrant caution."[97] This was followed by the U.S.-sponsored resolution in the UNEP Governing Council mentioned above.[98] In a memo to the Secretary of Agriculture, the President also directed that:

> [H]igh priority be given to: (1) improved monitoring of world forests; (2) research on preservation of natural forest ecosystems; (3) research on tropical forest multiple use management; (4) studies on increasing yields of tropical agriculture; (5) demonstration of integrated projects of reforestation, efficient fuel wood use and alternative energy sources; and (6) examination of how U.S. citizens and corporations can be encouraged to follow sound forest management practices.[99]

An interagency task force of deforestation, established in November 1979,[100] recommended that assessments of deforestation be a component of environmental impact statements and that any overseas U.S. projects by federal agencies and private institutions contain assessments of the effects of the planned activities on tropical forests.[101]

Efforts can also be made at the regional level to address the problem of deforestation. In South America, for example, the new Amazon Pact[102] offers a possible umbrella for such discussions and for an exchange of data.

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94. [1979] 2 INT'L ENVIR. REP. (BNA) 839-41.

95. *Id.* The UNEP meeting in Kenya advocated that the global community should give "urgent consideration" to the building up of alternative energy supplies such as solar power and windpower, which should take over from the carbon dioxide producing fuels. 3 Int'l Envir. Rep. (BNA) 241.

96. 15 WEEKLY COMP. OF PRES. DOC. 1353, 1371-73 (Aug. 2, 1979).

97. *Id.* at 1371.

98. [1979] 2 INT'L ENVIR. REP. (BNA) 839-41.

99. *Id.*

100. *Id.*

101. [1978] INT'L ENVIR. REP. (BNA) 48-49.

102. Treaty for Amazonian Cooperation, *done at* Brasilia July 3, 1978, *reprinted in* 17 INT'L LEGAL MAT. 1045 (1978).

E. *Preventive Strategies for Chlorofluorocarbons*

The experience of the United States in attempting to limit emissions of chlorofluorocarbons, which damage the ozone layer, offers useful insights into the problems associated with limiting carbon dioxide emissions. In March 1978, the Food and Drug Administration and the Environmental Protection Agency issued regulations banning the manufacturing and shipping of fluorocarbons for nonessential aerosol uses.[103] The ban is expected to reduce total chlorofluorocarbon emissions by considerably less than twenty-five percent globally.[104] The Clean Air Act requires the Environmental Protection Agency, *inter alia*, to conduct studies of the ozone problem in an effort to determine what further regulation of chlorofluorocarbons is necessary.[105] In October 1980 EPA proposed a set of rules which would impose mandatory emission controls for users of chlorofluorocarbons and would limit chlorofluorocarbon production through distribution of marketable production permits.[106] In response to comments to the proposed rulemaking, EPA has backed off from these approaches and is now trying to develop with NASA an early warning system to detect ozone depletion. The Clean Air Act also requires the National Oceanic and Atmospheric Administration to establish a continuing program of research and monitoring of changes in the stratosphere and of climatic effects resulting from this change.[107] The results to date indicate that chlorofluorocarbon concentration is increasing at five to ten percent per year, but do not show positive evidence of chlorofluorocarbon depletion of the ozone layer.[108] The impact of the aerosol ban may not be visible for a number of years. Two states—Oregon and Michigan—have passed legislation banning nonessential aerosol use of chlorofluorocarbon compounds in an effort to protect the ozone layer.[109]

Action has also been taken in the European Community to limit the use of chlorofluorocarbons in aerosol sprays. On December 17, 1979, the Environment Ministers of the European Economic Community adopted a proposal which would reduce chlorofluorocarbons in aerosol sprays by thirty percent of 1976 levels over the following two years (December 1979 to December 31, 1981), and which would limit production of chlorofluoro-

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103. 43 Fed. Reg. 11,301-26 (1978). *See also* 40 C.F.R. §§ 762.45 *et seq.* (1981).

104. Stoel, Compton & Gibbons, *International Regulation of Chlorofluoromethanes*, 3 ENVT'L POL'Y & L. 130 (1977).

105. 42 U.S.C. § 7453 (1980).

106. Advance Notice of Proposed Rulemaking, 45 Fed. Reg. 66726 (1980).

107. 42 U.S.C. § 7454 (1980).

108. Conversation with Dr. Lester Machta, Director of Air Resources Laboratories, NOAA (Jan. 13, 1980).

109. Or. Rev. Stat. §§ 468.605, 468.996(6); Mich. Comp. Laws. Ann. §§ 336.103, 336.107 (effective Mar. 31, 1977). Maine and Minnesota also enacted legislation prohibiting aerosol sprays containing chlorofluorocarbons for certain uses. [1977] 8 ENVIR. REP. (BNA) 179, 666. The New York Department of Environmental Conservation adopted regulations requiring warning labels on aerosols with chlorofluorocarbons. *Id.* at 135. At one time, 20 states were considering some type of legislation. *Id.* at 1693-94.

carbons F-11 and F-12 to present levels.[110] Several delegations pushed for a stricter standard, since the standard is less strict than in some existing national laws. Support for a stricter standard also came from two other directions: (1) the European Parliament's Environment, Public Health and Consumer Protection Committee, which adopted a resolution at a meeting in Brussels in November 1979 calling for a fifty percent reduction in the use of chlorofluorocarbons by 1981, and a total ban by 1983;[111] and (2) the conclusion of UNEP's International Scientific Committee at its third session in Paris in November 1979, that aerosol propellants, such as hydrofluorocarbons, could destroy fifteen percent of the ozone layer within one hundred years if present levels were maintained.[112] The European Economic Community called for a reexamination of the problem "in light of available scientific and economic data" in order to adopt necessary and new measures by June 30, 1981.

Some countries have acted unilaterally. Sweden banned aerosol manufacture and importation in December 1977.[113] West Germany, through cooperative government-industry consultation, has been able to get German industries to agree to reduce aerosol chlorofluorocarbon use by twenty-five percent by 1979 and fifty percent by 1981.[114] Canada has initiated "voluntary" reductions of aerosol use of chlorofluorocarbons.[115]

The OECD has limited its involvement to studies of the economic impact of chlorofluorocarbon regulation. UNEP has assumed the role of coordinating scientific research on the subject for the international community.

Developments in the regulation of chlorofluorocarbons offer some insights into the issues that will be raised in regulating carbon dioxide emissions. On the one hand, it should be possible to develop further and maintain the scientific network necessary for proper monitoring of carbon dioxide. On the other hand, it will be very difficult to obtain the international agreement necessary to manage a global pollution problem. The countries that have been most willing to regulate chlorofluorocarbons, except for the United States, have been those which contribute least to the problem. Canada is responsible for only two percent of the world's chlorofluorocarbons and Sweden does not manufacture any.[116]

The central problem in the transnational regulation of chlorofluorocarbons has been the inability of countries to agree upon a strict standard

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110. [1980] 3 INT'L ENVIR. REP. (BNA) 3.

111. *Id.*

112. *Id.*

113. Amendment of Ordinance 1973-334 on Products Hazardous to Health and the Environment adding Section 486, [1977] Swedish Fed. Stat. 1095, *codified in* [1973] SWEDISH CODE OF STATUTES 329.

114. T. Stoel, International Regulation of Fluorocarbons V-(1-2) (Apr. 17, 1979) (draft paper available from the Natural Resources Defense Council).

115. II CAN. STAT. Ch. 72 (1975).

116. Stoel, *supra* note 114, at VII-(6-7).

limiting the use of certain aerosol sprays containing these chemical components. In many ways the chlorofluorocarbon and carbon dioxide problems are the same. The number of countries which are major contributors—the developed countries—is small. The effect of polluting the ozone layer with chlorofluorocarbons is the depletion of a global resource. The effect of an increase in carbon dioxide is a global rise in temperature. Yet the modest success both in the United States and most recently in the European community in achieving at least some form of regulation on the emission of chlorofluorocarbons offers some hope for building such measures to control the emission of carbon dioxide. Carbon dioxide poses a much tougher problem. Unlike chlorofluorocarbons, its source is at the heart of a country's economy—the production and use of fossil fuels for energy or the removal of its forests.

F. *Adaptive Strategies for Carbon Dioxide Pollution*

If significant climatic changes occur as a result of temperature increases from carbon dioxide, adaptive strategies will be necessary, at least some of which are likely to focus on preventing the problem from worsening. The experience of dealing with problems of air and water pollution suggests that one potential response should be an attempt to diminish the levels of CO_2 pollution. Thus, one component of the adaptive strategy is likely to be an intensified search for technical solutions, such as ways to expand the capacity of oceans to absorb carbon dioxide or to limit carbon dioxide emissions. Nevertheless, the effects of possible climatic change, particularly upon water supplies and migration patterns, and upon the general dislocation of a country's economy, must also be anticipated.

How states adapt to climatic change will depend on whether or not the changes are beneficial or adverse to their economic and strategic interests. Studies are needed in order to determine who is likely to be affected, in what manner, and at what time, by what degree of climatic change. In the absence of hard data, probably the best contribution is to explore the consequences of various credible climate scenarios. It will be in the interest of those countries that are likely to be adversely affected to join together in measures to alleviate the stress and damage caused by climatic changes. The implications of such alternative state responses to climate change for our international economic and monetary system and for international political stability must also be addressed.

CONCLUSIONS

Carbon dioxide accumulation in the atmosphere is a problem during this century of transition from a fossil fuel to a primarily nonfossil fuel economy. A strategy must be developed for managing the atmospheric concentration of carbon dioxide so that CO_2 levels do not cause either serious adverse climate changes or changes in climate which overwhelm the capacity of countries to adapt to them. The strategy should include control of CO_2 emissions, use of those renewable energy resources that are environmentally sound, energy conservation, and management of for-

ests and soils for sustained yields.

But the management of carbon dioxide must be put into perspective—many scientifically generated facts concerning projected increases and resulting climatic changes are still unclear. This means that the topic should not be pushed into high-level political debates that would cause countries to adopt premature positions based on inconclusive premises and embedded in national political rhetoric. On the other hand, international scientific collaboration on the climatic and societal impact of increased concentrations of carbon dioxide should be promoted and systematic assessments of alternative strategies for managing carbon dioxide emissions should be commenced. It is time to initiate serious discussions with industry about the feasibility of technological innovation to control or recycle CO_2 output, and about the incentives that would be needed. A dialogue should be initiated with other countries about developing processes for managing the CO_2 problem, building upon existing institutional networks.

More fundamentally, the carbon dioxide issue needs to be treated as an integral part of the international energy question. As things now stand, decisions as to whether to shift to nuclear energy, promote renewable energy sources, or rely on coal and synfuels will likely be taken largely independently of CO_2 considerations, but they will have a dramatic impact on the timing and rate of CO_2 accumulations. It is therefore essential that strategies for managing the atmospheric concentration of carbon dioxide be integrated into national and international energy policy. Raising international public consciousness of the problem is a necessary first step.